Aquatic Vegetation and Habitat Quality in the Lower Des Plaines River: 1985-1987

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Abstract
In the early 1980's, locally abundant populations of aquatic vegetation were observed in the lower Des Plaines River after being virtually absent for nearly 20 years. This study was conducted in 1985-1987 to characterize the aquatic vegetation community in a 13-mile reach (river miles 273-286) of the Des Plaines River and to assess aspects of habitat quality. Twenty species of aquatic macrophytes were identified; vegetation cover, estimated from ground-truth surveys and low-altitude color aerial photographs, reached 60 ha in August 1987. The most heavily vegetated areas were river miles 285.5, 279.5, 277, and 273.5. Sediments at these locations contained high levels of As, Cd, Cr, Cu, Fe, Hg, Pb, and Zn and aquatic macrophytes had high levels of Al, Ba, Cr, Co, Sn, V, Zn, and PCBs. At senescence, these accumulated substances can remain in macrophyte tissues or be released into the water or sediments, affecting overall habitat quality. Therefore, interactions between rooted vascular plants and toxic substances, particularly those in sediments, should be considered when assessing habitat quality.

Key words: aquatic macrophytes, Des Plaines River, Illinois, vegetation cover, aerial photography, heavy metals, PCB's

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Introduction

The Illinois River and its bottomland lakes have been virtually devoid of submersed and floating-leaved vegetation since the early 1960's (Bellrose et al. 1983, Havera et al. 1980). This decline has been linked to the release of wastewater, industrial effluents, and runoff. In the early 1980's, locally abundant populations of aquatic vegetation were observed in the Lower Des Plaines River. Because macrophytes modify and diversify habitat and fuel secondary production by producing oxygen, cycling nutrients, and providing cover for fishes and substrate for fish food organisms (Barko et al. 1986, Bennett 1971, Engel 1985, Raschke 1978, Wright et al. 1981), recent increases in aquatic vegetation should improve water and habitat quality (e.g., reduced turbidity, increased oxygen levels, larger and more diverse invertebrate populations, and an improved fishery).

Macrophytes also modify sediment and water chemistry (Dawson et al. 1978, Hutchinson 1975, Sculthorpe 1967, Westlake 1973), often by substance uptake and release (Hill 1979, Jaynes and Carpenter 1986, Smith and Adams 1986). Accumulated substances, both mineral nutrients and toxic substances, may remain in roots and rhizomes or be translocated to other plant parts (i.e., acropetal translocation). During plant senescence, these substances may associate with decomposing particulate matter or leach into the water column. Thus, substances concentrated from deeper sediments can be moved into the water column and top sediments (Campbell et al. 1985, Everard and Denny 1985, Gabrielson et al. 1984, Howard-Williams and Lenton 1975, Kraus et al. 1986, McIntosh et al. 1978, Smith and Adams 1986, Welsh and Denny 1976).

Sediments of the Lower Des Plaines River are characterized by the presence of toxic substances, and rooted aquatic macrophytes are capable of mobilizing these sediment-bound substances. The purpose of this study was to assess habitat quality in the

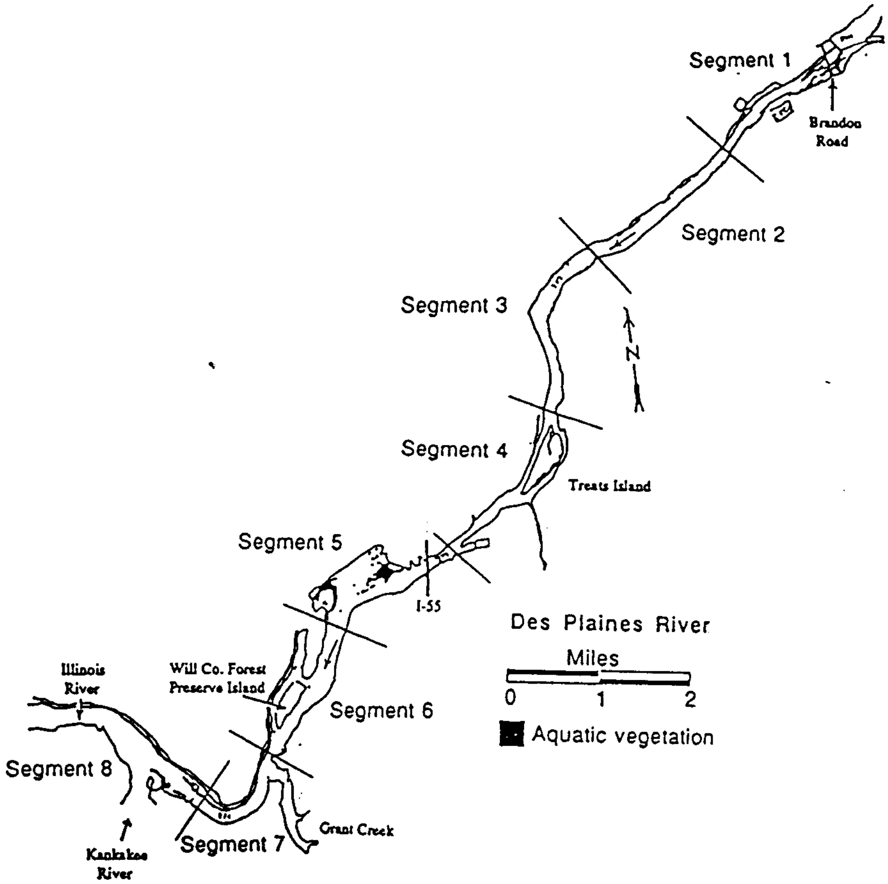

Figure 1. Location and extent of aquatic vegetation beds in the lower Des Plaines River (river miles 273-286) in August 1987.

Lower Des Plaines River by (1) documenting the extent and species composition of the aquatic macrophyte community, (2) chemically analyzing water, sediments, and macrophyte tissues for heavy metals, PCBs, and organic pesticides, and (3) examining toxic substance interactions between sediments and macrophytes.

Study Site

The study site, in Will and Grundy counties, Illinois, includes a reach of the Des Plaines River from Brandon Road Lock and Dam (RM 286) to the confluence of the Des Plaines and Kankakee rivers (RM 273) (Fig. 1). The tributary Grant Creek enters the Des Plaines River near RM 274; Mobil Oil, AMOCO, Olin Matheson, Commonwealth Edison, and Rexall Chemical are located along this reach. Treated effluents released into the Sanitary and Ship Canal by the Metropolitan Sanitary District of Greater Chicago enter the Des Plaines River 4 miles upstream of the study reach. Toxic sediments have been identified in the North Branch of the Chicago River and the Des Plaines River (Blodgett et al. 1984, Illinois Environmental Protection Agency 1984).

The study reach was divided into eight segments of approximately equal size (Fig. 1). Segment boundaries were delimited without separating heavily vegetated areas.

Materials and Methods

Low-altitude, natural-color aerial photography and ground-truth surveys (Motorola Mini-Ranger III System, transect methods, and hand mapping) were used to document location, extent, and species composition of

Table 1. Macrophytes collected in the Des Plaines River for chemical analyses in 1986 and 1987. Water and sediments were collected at all locations. RM = river mile.

Location	Macrophytes	1986	1987
Segment 1 (RM 285.5)	Eleocharis acicularis	x	x
	Myriophyllum sp.		x
	Potamogeton cripsus		x
	Potamogeton nodosus		x
	Potamogeton pectinatus		x
Segment 4 (RM 279.5)	Sagittaria latifolia	x	x
	Typha sp.	x	x
Segment 5a (RM 277.5)	Myriophyllum sp.	x	
	Potamogeton cripsus	x	
	Potamogeton nodosus	x	
	Potamogeton pectinatus	x	
	Vallisneria americana	x	x
Segment 5b (RM 276.8)	Myriophyllum sp.		x
	Potamogeton nodosus		x
	Potamogeton pectinatus		x
Segment 8 (RM 273.5)	Potamogeton pectinatus		x
	Vallisneria americana		x

aquatic macrophytes in June or July, 1985-1987. Voucher specimens were collected, identified (Beal 1977, Correll and Correll 1972, Fassett 1967), and archived in the Illinois Natural History Survey Herbarium (ILLS). Data were recorded on base maps, digitized, and entered into a Geographic Information System (ARC/INFO) (Sparks et al. 1986, Tazik and Sparks 1987, Tazik 1988).

Eight macrophyte species (two emersed and six submersed) were collected and chemically analyzed in 1986 (Table 1). In 1987, macrophytes, water, and sediments samples were collected from five locations for chemical analysis. Prior to chemical analysis, macrophytes were divided into above-ground (shoots) and below-ground (roots) parts. Each sample analyzed was a composite or homogenate of several subsamples to assure thorough representation of the water, sediments, and plant species at each location. Samples were chemically analyzed for total cations using standard methods (Tazik 1988). Substances measured at or below detection limits for all sample sites or macrophyte species are not reported here.

Correlation analyses were used to examine the association between substance levels in sediments and plant tissues. Average linkage cluster analyses were used to identify similarities in sediments from the five locations, similarities in macrophyte species, and similarities between sediments and macrophyte tissues. (Pielou 1984, Sokal and Rohlf 1969, Wilkinson 1987). Variances were equalized prior to cluster analysis to prevent swamping of uncommon elements or those in lower concentrations by abundant elements (i.e., having higher means and variances) (Pielou 1984). For details of chemical analyses, mineral nutrient concentrations, macroinvertebrate communities, and

Table 2. Aquatic macrophytes collected in the Des Plaines River, 1985-1987. Growth forms are rooted (R), submersed (S), emersed (E), aquatic (A), terrestrial (T), floating (F), and floating-leaved (FL).

Scientific name	Common name	Growth form
Calamagrostis	Reed bentgrass	R T
Ceratophyllum demersum L.	Coontail	F A
Dianthera americana L.	Water willow	R E A
Eleocharis acicularis (L.) R. & S.	Needle rush	R E A
Elodea canadensis (Michx.) Planchon.	American elodea, waterweed	R S A
Gramineae	Grass family	R T
Lemna spp.	Duckweed	F
Lythrum salicaria L.a	Purple loosestrife	R E A
Myriophyllum sp.	Water milfoil	R S A
Nelumbo lutea (Willd.) Pers.	American lotus	R FL A
Nymphaea tuberosa Painea	White water lily	R FL A
Phragmites communis Trin.	Reed grass	R E A
Polygonum sp.	Smartweed	R T
Potamogeton crispus L.	Curlyleaf pondweed	R S A
Potamogeton pectinatus L.	Sago pondweed	R S A
Potamogeton zosteriformis Fernald.	Flatstem pondweed	R S A
Potamogeton nodosus Poirb	American pondweed	R FL A
Sagittaria latifolia L.	Common arrowhead	R E A
Scirpus fluviatilis (Torr.) Gray	River bulrush	R E A
Scirpus validus Vahl.	Soft-stem bulrush	R E A
Typha angustifolia L.	Narrowleaf cattail	R E A
Typha latifolia L.	Common cattail	R E A
Vallisneria americana (Michx.)	Eelgrass	R S A

a New taxa in 1986
b New taxa in 1987

macrophyte standing crops, see Sparks et al. (1986), Tazik and Sparks (1987), and Tazik (1988).

Results

Species Composition and Cover

Twenty macrophyte species were collected from the study reach from 1985 to 1987 (Table 2). The total vegetated area (46 ha) was nearly identical in 1985 and 1986 (Table 3). There were slight differences in the amount of cover of individual species and within segments, but overall there was little change between the 2 years. Total vegetative cover increased to 60 ha in 1987, primarily due to an increase in submersed macrophytes in Segment 5 (Table 3). The areas most heavily vegetated in all years were Segments 1 (RM 285.5), 4 (RM 279.5), 5 (RM 277), and 8 (RM 273.5) (Table 3, Figs. 2-5). Potamogeton spp., Myriophyllum sp., and Vallisneria americana accounted for approximately 70% of the total vegetated area in all years, with the most extensive cover in Segments 1, 5, and 8. Emersed vegetation, primarily Sagittaria latifolia, covered over 10 ha of the study reach, primarily in Segments 2, 3, and 4 (RM 279-284).

Chemical Analyses

Water samples from all sites contained low levels of nearly every element measured. Concentrations of 16 of 26 elements measured were at or below detection limits; all remaining elements were within quality criteria established for aquatic life (US Environmental Protection Agency 1976).

Table 3. Coverage (ha) of macrophyte species in study segments in 1986 and 1987.

Macrophyte	Segment 1	2	3	4	5	6	7	8	Total
				1986					
Ceratophyllum demersum	-	-	-	-	-	-	0.01	-	0.01
Myriophyllum sp.	0.82	0.02	-	-	-	0.02	-	-	0.86
Potamogeton pectinatus	-	0.02	-	-	-	0.02	-	-	0.04
Potamogeton crispus	0.19	-	-	-	-	-	0.02	-	0.21
Potamogeton zosteriformis	-	-	-	-	-	0.03	-	-	0.03
Potamogeton nodosus	0.17	-	-	-	-	-	-	-	0.17
Potamogeton spp. mix	0.34	-	-	-	-	-	-	-	0.34
Submersed species mix	8.77	-	-	-	14.62	0.09	0.09	8.55	32.12
Nymphacea tuberosa	-	-	-	-	-	-	0.12	-	0.12
Lythrum salicaria	-	-	-	-	-	-	0.02	-	0.02
Phragmites communis	-	-	0.05	0.06	-	-	-	-	0.11
Sagittaria latifolia	0.32	0.78	1.80	6.91	0.07	0.07	0.04	0.06	10.05
Typha spp.	-	-	0.10	1.48	0.18	-	0.26	0.11	2.13
Emersed species mix	-	-	-	-	-	-	0.04	-	0.04
Total	10.61	0.82	1.95	8.45	14.87	0.23	0.60	8.72	46.25
				1987					
Ceratophyllum demersum	-	-	-	-	-	-	-	-	-
Myriophyllum sp.	0.29	-	-	-	-	-	-	-	0.29
Potamogeton pectinatus	-	-	-	-	-	-	-	-	-
Potamogeton crispus	-	-	-	-	-	-	-	-	-
Potamogeton zosteriformis	-	-	-	-	-	-	-	-	-
Potamogeton nodosus	0.09	-	-	-	-	-	-	-	0.09
Potamogeton spp. mix	-	-	-	-	-	-	-	-	-
Submersed species mix	9.00	-	-	-	24.57	0.47	0.32	8.06	42.42
Nymphacea tuberosa	-	-	-	-	-	-	0.13	-	0.13
Lythrum salicaria	-	-	-	-	-	-	-	-	-
Phragmites communis	-	-	-	0.03	-	-	-	-	0.03
Sagittaria latifolia	0.48	3.07	3.67	7.05	0.07	0.10	-	0.09	14.53
Typha spp.	-	-	-	1.64	0.14	-	0.12	0.18	2.08
Emersed species mix	-	-	-	-	-	-	0.20	0.06	0.26
Total	9.86	3.07	3.67	8.72	24.78	0.57	0.77	8.39	59.83

Sediments samples in 1987 (Table 4) contained As, Cd, Cr, Cu, Fe, Hg, Pb, and Zn at highly elevated or extreme levels, the two highest categories of the Illinois Stream Classification System (Illinois Environmental Protection Agency 1984, Kelly and Hite 1984). Dieldrin and heptachlor epoxide were not detected and PCBs in the sediments were generally <1 ppm. All but a few substances were found in higher concentrations in sediments than in plant tissues (Table 5).

Substance concentrations in macrophyte tissues were generally comparable with those measured in other studies, although Zn levels were often higher in our plants (Campbell et al. 1985, Cowgill 1974, DiGiulio and Scanlan 1985). PCBs, Co, and Mn were consistently accumulated in greater amounts in macrophyte tissues than in sediments, while Zn and Ni were frequently present in amounts comparable to those in the sediments (Tables 4 and 5). Levels of Co, Cr, Se, Sn, and V were generally higher in plant roots than in shoots. Conversely, shoots had higher levels of PCBs, Zn, and Mn levels than did roots. Eleocharis acicularis, Myriophyllum sp., and

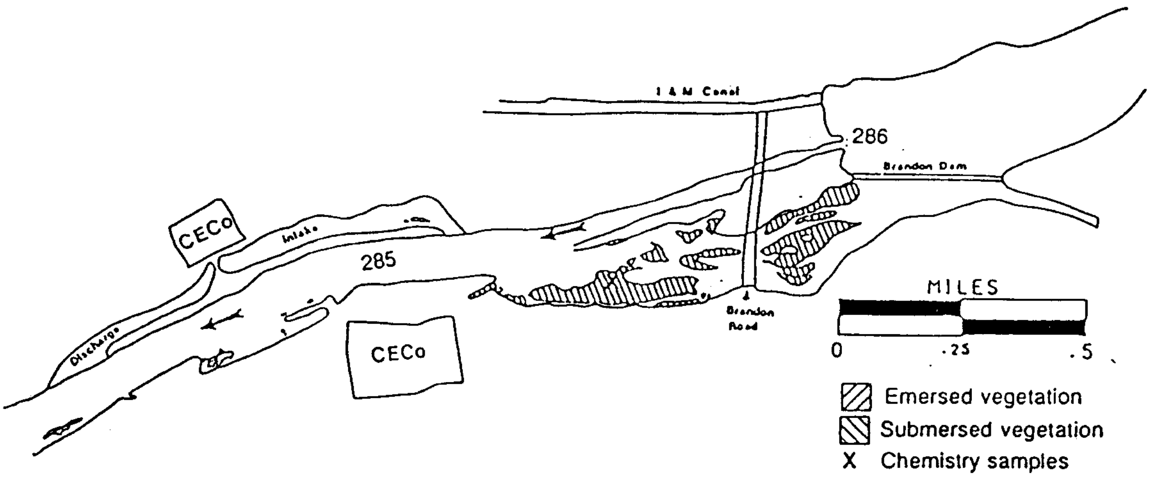

Figure 2. Location and extent of aquatic vegetation beds, Segment 1, lower Des Plaines River, August 1987.

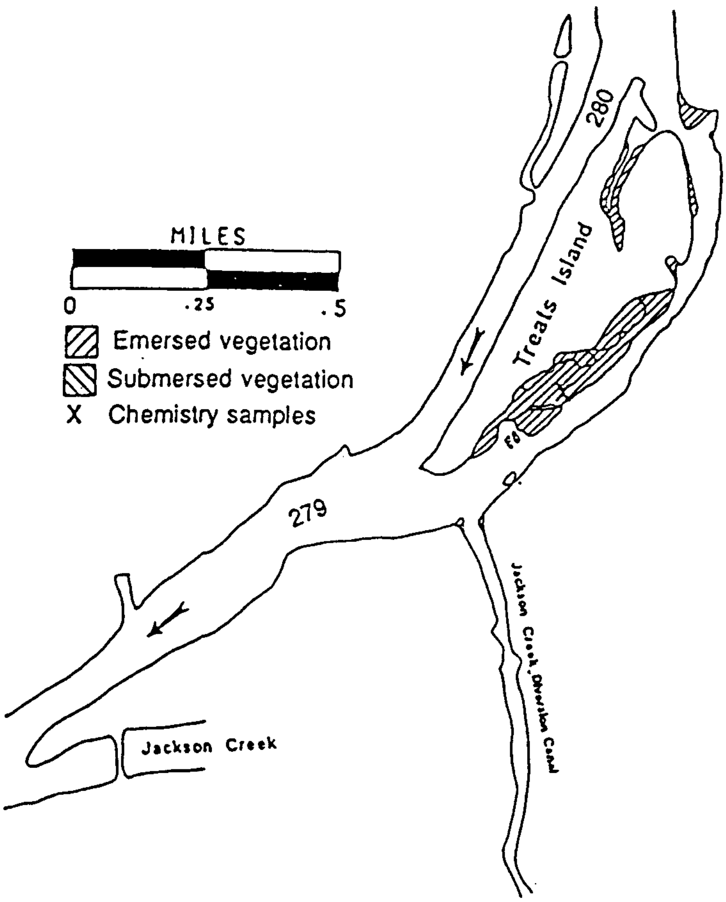

Figure 3. Location and extent of aquatic vegetation beds, Segment 4, lower Des Plaines River, August 1987.

Figure 4. Location and extent of aquatic vegetation beds, Segment 5, lower Des Plaines River, August 1987.

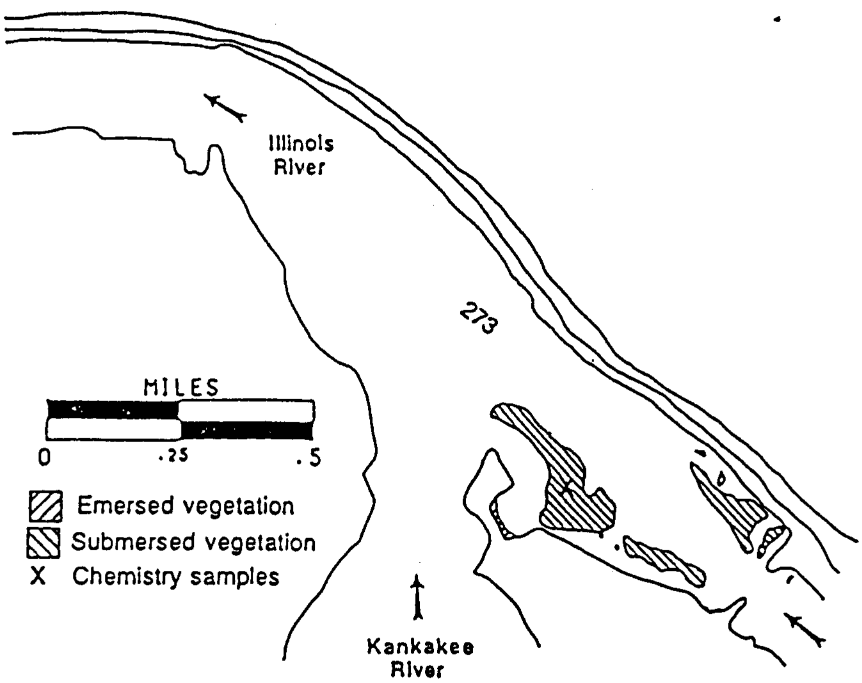

Figure 5. Location and extent of aquatic vegetation beds, Segment 8, lower Des Plaines River, August 1987.

Table 4. Concentration of minerals, metals, and PCB's in sediments collected from the Des Plaines River (RM 273-286), 1987. All concentrations are reported in ppm except Hg (ppb). Detection limits are in parentheses, concentrations less than detection limits are noted as <DL.

	Segments				
	1	4	5a	5b	8
Al (31.0)	35800	20300	26000	32000	41700
As (30.0)	44.5	<DL	<DL	34.5	47.0
B (2.80)	94.5	45.0	45.0	88.0	149.0
Ba (0.000)	221	376	320	714	602
Cd (3.80)	14.5	32.0	24.0	37.0	50.0
Cr (19.2)	40	188	134	255	344
Cu (3.40)	<DL	147.0	76.5	277.0	342.0
Fe (19.6)	40600	47100	29000	35800	37400
Hg (5.00)	91	1850	679	4180	3780
Mn (5.00)	1160	1450	1080	1040	1210
Ni (6.20)	69.5	121.0	46.0	71.0	76.0
Pb (11.6)	<DL	99	<DL	284	249
Sn (27.2)	<DL	41.5	<DL	56.5	119.0
V (27.2)	72.5	60.0	56.0	59.5	123.0
Zn (8.60)	197	1020	620	123	157
Total PCB (0.0001)	0.060	1.650	0.415	0.289	0.557

Vallisneria americana effectively accumulated Ba, Cd, Co, Cr, Ni, Zn, and PCBs (Table 5).

There were no significant correlations between substance levels in sediments and plant tissues. Cluster analyses showed no strong groupings of substance levels in sediments from the five locations. The strongest plant species groupings were identified in a cluster analysis of Cd, Cr, Hg, and Zn levels in plant roots; Potamogeton spp. grouped together, indicating that substance levels in roots were similar for species of that genus, and Vallisneria and Eleocharis grouped with Myriophyllum sp. in a cluster distinct from Potamogeton spp. (Fig. 6).

Discussion

A wide variety of submersed and emersed vegetation now inhabit the Lower Des Plaines River; all are typical temperate, riverine species (Clark et al. 1983, Donnermeyer and Smart 1985, Sparks 1984). Vegetation was abundant in four areas in all years; vegetation cover appeared to be increasing in Segments 2, 3, and 5.

Most trace metals entering aquatic systems eventually become incorporated in the sediments (Miller et al. 1983, Tessier and Campbell 1987). The Des Plaines River has been subjected to considerable pollution and its sediments are characterized by high levels of As, Cd, Cr, Cu, Hg, Pb, and Zn (Blodgett et al. 1984, Commonwealth Edison Co. 1986, Illinois Environmental Protection Agency 1984). The presence of toxic substances, and their availability to the biota, impacts habitat quality. Analysis of total cations is just the first step in understanding potential interactions of pollutants with biotic and abiotic components.

Many factors influence rates and patterns of substance concentration and translocation by aquatic macrophytes. Patterns observed may have been affected by (1) combining roots and rhizomes for analysis, (2) analyzing plants of varying age, (3) variation in local edaphic factors,

Table 5. Concentration of minerals, metals, PCBs, dieldrin, and heptachlor epoxide in macrophytes collected from the Des Plaines River (RM 273-286), 1986 and 1987. Samples designated by plant part were collected in 1987; other samples were collected in 1986. All concentrations are reported in ppm except Hg (ppb). Detection limits are in parentheses; concentrations less than detection limits are denoted <DL.

Macrophyte	Al (3.1)	B (0.28)	Ba (0.00)	Cd (0.38)	Co (0.30)	Cr (1.92)	Hg (5.00)	Mn (0.40)	Ni (0.62)
Segment 1									
Eleocharis acicularis	13500	43.4	168.0	14.40	12.4	73.6	347.0	4980	144.0
roots	7950	18.9	93.6	12.30	29.0	25.1	128.0	2430	87.7
shoots	1110	<DL	57.5	1.50	23.5	<DL	45.2	4840	68.1
Myriophyllum sp.									
roots	11200	39.7	72.9	9.05	31.3	30.8	110.0	887	71.5
shoots	1160	50.8	41.3	1.35	13.1	8.9	161.0	2340	44.4
Potamogeton crispus									
roots	3440	33.8	92.8	3.75	22.9	10.3	66.8	2710	64.2
shoots	1210	12.1	27.3	1.30	5.0	6.8	44.2	512	24.5
Potamogeton nodosus									
roots	6870	43.5	69.9	5.40	28.4	14.9	69.3	1230	58.8
shoots	1010	9.0	31.0	1.25	10.1	4.2	48.3	1400	40.6
Potamogeton pectinatus									
roots	1900	45.5	41.8	2.55	14.5	3.0	84.0	1000	29.1
shoots	1080	477.0	29.2	1.65	11.3	8.3	131.0	1550	47.3
Segment 4									
Sagittaria latifolia	4560	46.7	122.0	6.95	1.0	32.7	276.0	1300	44.1
roots	1020	17.1	106.0	3.40	6.5	8.3	124.0	195	11.8
shoots	529	3.3	9.2	0.75	1.3	6.5	66.6	105	4.9
Typha sp.	575	22.9	15.6	1.35	<DL	5.2	67.2	156	7.6
Segment 5a									
Myriophyllum sp.	6000	76.3	204.0	6.25	7.7	35.9	204.0	1360	44.0
Potamogeton cripsus	3900	43.9	102.0	5.20	3.6	28.7	242.2	614	40.8
Potamogeton nodosus	3340	35.1	113.0	4.35	4.0	28.1	236.0	958	52.0
Potamogeton pectinatus	3720	176.0	94.7	3.65	9.5	27.0	138.0	1120	100.0
Vallisneria americana	4560	46.7	122.0	6.95	1.0	32.7	276.0	1300	44.1
roots	4670	53.9	390.0	17.30	32.8	70.8	931.0	1120	55.8
shoots	2620	11.3	58.9	7.10	34.0	18.5	174.0	2740	88.5
Segment 5b									
Myriophyllum sp.									
roots	3450	47.4	509.0	6.70	39.8	<DL	81.5	1510	18.2
shoots	4410	69.0	89.7	1.60	8.7	2.3	38.1	2720	9.5
Potamogeton nodosus									
roots	1960	32.4	337.0	3.65	14.7	2.2	64.4	1200	8.4
shoots	2200	21.6	58.5	1.30	7.4	3.6	47.3	7700	16.3
Potamogeton pectinatus									
roots	2440	66.0	370.0	3.40	12.9	<DL	74.1	1410	6.0
shoots	3040	229.0	112.0	1.60	12.3	<DL	46.1	9300	19.0
Segment 8									
Potamogeton pectinatus									
roots	2850	79.0	215.0	4.60	13.2	19.3	156.0	1190	21.9
shoots	7650	241.0	141.0	4.85	29.5	10.4	61.6	5680	73.9
Vallisneria americana									
roots	3110	60.3	447.0	12.70	28.1	19.2	201.0	707	27.2
shoots	3030	7.8	51.4	5.95	19.0	14.4	106.0	2610	119.0

Table 5 (concluded).

Macrophyte	Pb (1.16)	Se (2.42)	Sn (2.72)	Total V (2.72)	Zn (0.860)	PCB (0.0001)	Dieldrin (0.0001)	Heptachlor epoxide (0.0001)
Segment 1								
Eleocharis acicularis	18.8	<DL	20.00	28.0	508.0	21.700	0.1000	<DL
roots	<DL	12.0	8.95	24.0	306.0	1.220	<DL	0.0072
shoots	13.7	<DL	<DL	<DL	184.0	1.470	<DL	<DL
Myriophyllum sp.								
roots	<DL	18.8	7.50	31.9	178.0	1.100	0.0092	0.0096
shoots	6.8	6.2	<DL	2.8	168.0	1.340	0.0036	0.0050
Potamogeton crispus								
roots	<DL	4.5	<DL	5.0	156.0	0.997	0.0078	0.0088
shoots	<DL	<DL	<DL	8.3	195.0	1.100	0.0054	0.0078
Potamogeton nodosus								
roots	<DL	12.4	5.60	15.8	115.0	0.722	0.0040	0.0063
shoots	<DL	<DL	4.10	<DL	165.0	2.270	<DL	0.0087
Potamogeton pectinatus								
roots	<DL	3.3	5.85	4.1	82.0	0.866	0.0057	0.0072
shoots	<DL	3.4	<DL	<DL	327.0	1.130	0.0022	0.0052
Segment 4								
Sagittaria latifolia	20.2	<DL	3.90	15.4	298.0	1.064	<DL	<DL
roots	<DL	4.8	<DL	5.6	93.3	0.557	<DL	0.0084
shoots	<DL	<DL	<DL	<DL	47.7	1.230	0.0050	<DL
Typha sp.	2.7	<DL	2.18	<DL	58.2	0.244	0.0016	<DL
Segment 5a								
Myriophyllum sp.	29.3	<DL	2.80	18.0	262.0	3.020	<DL	<DL
Potamogeton crispus	9.4	<DL	9.00	9.8	268.0	1.250	<DL	<DL
Potamogeton nodosus	17.0	<DL	6.55	8.5	206.0	2.110	<DL	<DL
Potamogeton pectinatus	14.3	<DL	<DL	10.4	244 0	0.908	<DL	<DL
Vallisneria americana	16.7	<DL	7.35	24.7	557.0	1.800	<DL	<DL
roots	48.6	18.0	8.63	26.7	467.0	0.653	0.0031	0.0066
shoots	6.2	4.7	4.90	9.4	535.0	0.900	<DL	<DL
Segment 5b								
Myriophyllum sp.								
roots	<DL	21.6	3.05	8.7	66.4	0.593	0.0042	0.0119
shoots	<DL	5.5	<DL	6.9	68.8	0.565	<DL	0.0064
Potamogeton nodosus								
roots	<DL	7.4	<DL	12.6	44.0	0.852	0.0038	0.0046
shoots	<DL	2.5	3.35	7.5	53.9	1.340	0.0127	<DL
Potamogeton pectinatus								
roots	<DL	11.7	5.50	12.4	28.9	0.922	0.0064	0.0088
shoots	<DL	3.6	<DL	6.3	41.5	0.630	0.0125	0.0100
Segment 8								
Potamogeton pectinatus								
roots	<DL	8.0	5.70	18.2	115.0	1.300	0.0100	<DL
shoots	<DL	9.9	4.70	15.3	206.0	1.130	0.0040	0.0046
Vallisneria americana								
roots	<DL	19.1	7.50	24.5	222.0	0.854	0.0030	0.0064
shoots	<DL	4.1	7.50	4.3	524.0	0.837	0.0108	<DL

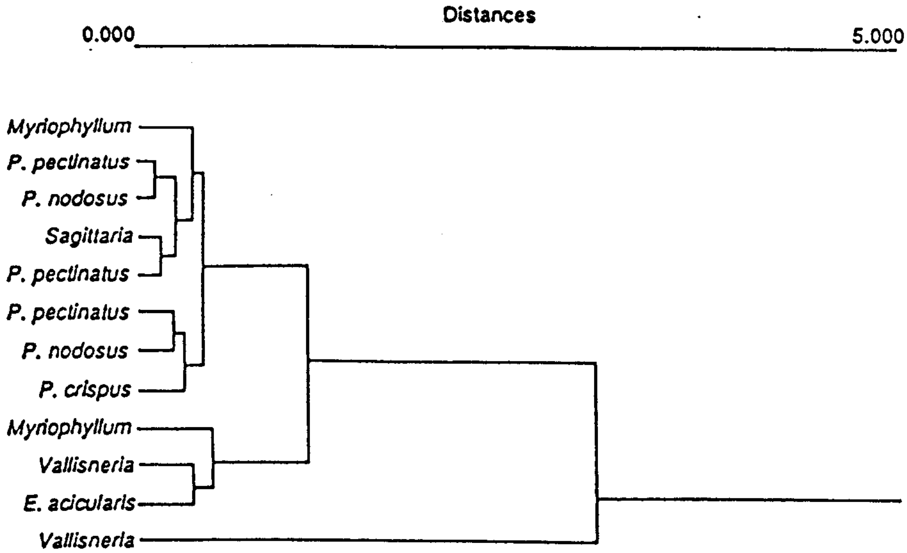

Fig. 6. Dendogram of cluster analysis of cadmium, chromium, mercury and zinc concentrations in macrophyte roots. The average linkage method is used, distance is measured in Euclidean distance (SYSTAT™).

and (4) differential uptake of substances (Campbell et al. 1985, Kraus et al. 1986, Kraus 1988, Miller et al. 1983). These data are not sufficient to establish a statistically significant relationship between substance concentrations in sediments and in plants; 65% of 105 cases examined by Campbell et al. (1985) showed no relation between these parameters. Nor do these data define individual macrophyte uptake and translocation processes. Nonetheless, substantial quantities of toxic substances were identified in sediments and macrophyte tissues. Once substances are concentrated by macrophytes, they may be stored in macrophyte tissues or released into the environment. For Co, PCBs, and Hg, which were concentrated by macrophytes to levels that exceeded those in sediments, release into the environment could pose a serious threat to other biota. Conversely, harvesting contaminated plants could be used as part of a rehabilitation plan. Cd, Co, Cr, V, Sn, and Se which are concentrated primarily in roots and rhizomes could also be removed from the system by harvesting macrophytes; moreover, this removal would not be complicated by seasonal senescence of shoots.

In conclusion, there is now locally abundant aquatic vegetation in the Lower Des Plaines River (RM 273-286). As macrophyte populations increase, water and habitat quality should improve (e.g., reduced turbidity, increased oxygen levels, larger and more diverse invertebrate populations, and an improved fishery). Toxic substances are clearly a part of this aquatic system, and interactions of aquatic plants and toxic substances, particularly those in sediments, can affect habitat quality. Rooted macrophytes can move toxic substances from deeper sediments to the water column and top sediments via uptake and acropetal translocation.

Conversely, substances that are concentrated and remain in belowground plant parts are unavailable to other biota, at least until those parts senesce. Removal of macrophytes that have accumulated toxic substances may provide a mechanism for rehabilitating polluted aquatic systems.

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